Making the Film

The Symbolics Graphics Division (SGD) undertook to do a film to show that its animation program was capable of attractive and challenging animation. The SIGGRAPH film show was thought the best forum for demonstrating Symbolics' commitment to its animation customers. Tom McMahon, executive producer of the film and director of SGD's R&D division, made the initial commitment to produce a 20-second spot that featured the advanced boids software program written by Craig Reynolds. It was Gary Demos's idea to feature the experimental flocking motions since the interest generated by the program would ensure the film's acceptance by the SIGGRAPH film jury.

The film was produced in conjunction with Whitney/Demos Productions (WDP), a new start-up animation production house that would be using the Symbolics software programs. WDP's interest was to learn as much as possible about the Symbolics system before taking in real jobs. WDP especially wanted practice on the animation program since it planned to extend the program for its own uses.

The film (video, really) turned out to be a learning experience not just for WDP but for the SGD software developers as well, many of whom had worked in only limited capacities on other people's films and flying logos, usually with a minimum amount of time. The opportunity to design and control a film project and the chance to show off the system excited almost everybody involved. Since the film would stretch over several months, the time and effort could be spent to do things the right way.

The film spawned several new features, some of which will eventually make it into a release, others that make use of existing undocumented programming features, and others that can be programmed by adding code to the Lisp environment. (See *Hints and Hacks for some of these.*
Not all the additions have been added to the animation program, nor will all make it in.

Getting off the ground

The 20-second flocking motion spot envisioned in the beginning didn't stay simple for very long. With WDP's Philippe Bergeron available and

willing, the film was expanded to include character animation. With characters comes a story and Robert Fusfield was asked to design a storyboard that combined character animation and flocking motion. The concept he came up with was a sort of love story between Stanley the bird and Stella the fish. The actual events of this love story changed over time, but Fusfield's original concept of a globe and separate worlds that in the end unite never changed.

The initial storyboard went under several titles; on that lasted a week was *Stanley Goes Fishing*, a title that proved to be unpopular (and, for the quesy, a tad chauvinistic) but that well reflected the storyboard's cartoonish quality. The final title, *Stanley and Stella in Breaking the Ice* was chosen after a lot of debate and marketing considerations (the Symbolics system breaks ice in many new ways), but in time to make it onto the jury version.

The schedule drawn up in January by the producer, Michael Wahrman, called for the jury version to be the complete animation with audio. The weeks after the jury version and before the final deadline would be used for rendering, re-rendering, and final fine-tuning. The animation was far from complete; in fact, the jury version used almost anything that had been done to illustrate the story--black-and-white storyboard frames, color storyboard frames, black-and-white S-Dynamics screen dumps, S-Geometry shaded scenes, rendered frames, and actual stills that had been modeled for use in the film. A black-and-white motion test was not done because it was thought a motion test would divert time and effort from the real work of animating. But a lot of animation had been completed for the jury version. All would have been well, except that nobody liked the jury version.

The cartoonish jury version made it clear that the static storyboard did not translate well into animated motion. The high number of cuts from scene to scene was excessive for a 68-second animation and made the story difficult to follow even for those who had seen the storyboard. Philippe Bergeron, both of the film project and the film jury, found himself having to explain the film to his fellow jurors. A more serious problem was strong objection of the Marketing department within SGD. For a few hours the continued happy existence of the film was in doubt.

But Tom McMahon recommitted the SGD staff to the film, and it was about this time that Larry Malone started taking a more active role in

directing the film. It was under his direction that it was decided to do the right but risky thing of redoing the story. The number of cuts was reduced and replaced with sweeping camera moves that slowly revealed the scene and allowed the viewer more of a feeling of the globe and its separate worlds. The length of the film was doubled since part of the jury version's incomprehensibility was the high speed at which the action unraveled. Simplifying the story also placed emphasis back on the flocking motion.

Redoing the storyboard was risky because it meant starting from scratch. Instead of five weeks to finish a 68-second film for which 30 percent of the animation was complete, the film-makers had five weeks to finish a 2-minute film for which only the models had been completed. It was now thought necessary to do a black-and-white motion test to ensure each scene was correctly timed. The new, speeded-up schedule allowed no time for fine-tuning or rendering scenes twice, as the original scheduled had called for. In fact, the final version delivered for the show still contained test frames (although a version without test frames was shown at the film show).

Modeling and creation of objects

Richard "Doc" Bailey constructed the characters after drawings made by Dean Foster. The construction of the models was pretty standard stuff--complex objects were constructed from simpler ones. Most objects were created with the spline surface feature of S-Geometry in which a 2D wire resembling a mesh or grid is shaped by manipulating control points. Once the desired shape is achieved, the surface is ?splined? to create a volume that is subdivided by polygons. (Step-by-step procedures for using this feature are given in *Helpful Hints and Hacks*.)

The fishes and birds are actually miniversions of Stanley and Stella. The miniversions were created by passing the models of Stanley and Stella through the *derezer*, a program written by Michael Wahrman that reduces detail by sorting and dissolving edges according to the hardness of the edge. (The hardness of edges is determined by the angle of two faces.) Where Stanley has around 11,000 polygons, little Stanleys have about 1,000 polygons. (The derezer will be in S-Geometry hacks file at 7.2.)

The ice barrier object that divides the globe required special attention because the ice barrier had to be solid, yet breakable; detailed for close-up shots, yet general enough for long-distance shots; static yet dynamic. These difficulties were solved by Kevin Hunter who added new mapping features to S-Render. Variable resolution bump maps were added so that bump-opacity map for the barrier had a 256 x 256 version for distant shots and a 1024 x 1024 version for close-ups. The sparkling effect was achieved with the use of dynamic bump maps. A dynamic map is actually a 3D fractal. Slices then are taken off the cube and used in successive frames.

The barrier is one object in shots previous to breaking. In the shot immediately before breaking, it is substituted for several objects that are closely packed. When Stanley breaks through, the objects fall away, each taking with it the map coordinates of the part of the map it belongs.

Character animation

The motions required for character animation are fluid, continuous, and repeatable. Translations and rotations, which are usually sufficient for rigid body transformations, are of limited value in character animation because an object itself is animated, its vertices move in relation to one another. For this reason, character animation requires different facilities. Larry Malone added features specifically to make character animation easier.

Character expressions, in which facial features objects, such as eyebrows and lips, were animated by an S-Geometry facility that allows an area around a selected vertex to be defined. When the selected vertex is moved, the defined area is affected. For example, to animate a smile, a point is chosen at the corner of the lips. As this point is moved out from the mouth to form the smile, the lips (as the defined area around the point) are pulled and stretched to follow the point. Areas of influence are not limited to facial expressions and can be used in all situations where there is continuous movement, such as the gentle bending of Stella's bottom fin.

Philippe Bergeron thus formed expressions by moving the vertices from a neutral state (the original state of the object as it was modeled);

these vertex displacements, which could be saved and named, were later animated in S-Dynamics. (See *Hints and Hacks* for step-by-step instructions on animating a displacement.) Philippe could combine several displacements together for more complex expressions (a Stanley that was at the same time surprised and happy).

Motions of different objects could be linked to one another. For instance, whenever Stanley smiles, his eyebrow rises. The eyebrow and mouth belong to unrelated subsequences that are linked to one another in S-Dynamics so that a change in one automatically propagates to the other.

For the eye movement, Philippe used a technique he employed on *Tony De Peltrie* in which the eyes are focused on a point of interest. If the head moves, the eyes shift to remain focused on the point of interest; if the point of interest moves, so do the eyes. The point of interest in this film was a scaling center. [Need more info from Malone about this.]

Behavior animation

The centerpiece of the film is Craig Reynolds's boids program. Boids is an experimental program that simulates flocking motion. The paths of the individual boids are not scripted but are determined by a system of constraints. The responsibility for decision-making belongs to the object rather than the animator. The benefits of such a system for animation are clear. A higher number of objects (wide shots of the film contained approximately 90 fish and 70 birds) can be animated without having to explicitly state the motions for each. The boids program with its ability to script motion with general commands is a natural progression in the tendency of higher programming.

Boids is a type of particle system in which each particle is replaced by a geometrical object that has its own coordinate system. Like all objects, boids get their geometric abilities from the flavor **3d:object**. The flock is animated by passing generalized flight instructions to each boid. The flight instructions are actually vertices in a wire. The boids fly (or swim) first toward one vertex, then another. As long as a boid obeys three constraints, it's free to fly as it wants to obey the instructions.

1. Avoid collision with nearby flockmates.
2. Match the velocity of nearby flockmates.
3. Attempt to stay close to nearby flockmates.

Other constraints keep the boids flying level and without a lot of random side-to-side movements. All parameters are weighted, the most weighted being the avoidance of obstacles, the other parameters have declining importance. A boid can change velocity or bump a flockmate if this is what is required to avoid an obstacle. Each boid is aware of its environment by looking at the environment's database.

The flock simulations are invoked from scripts created and animated in S-Dynamics.

(If you look closely enough at scene 1 (?) you will see a boid fly through an obstacle. This occurs because the geometric location in this instance is different from the visual location. Since the boid depends upon the database for information, it is not concerned with the visual location of the obstacle. The bird was avoiding what it knew to be the geometric location.)

Putting it together

Four types of animation were combined in the scenes where Stanley breaks the ice. This was by far the most complex scene of the film. Four types of animation were present--behavior animation, the scripted paths of the camera and Stanley and Stella, script generated by code. The ice barrier objects after the break were rotated 90 degrees from the point where Stanley hits the ice.

Net Rendering

The entire film contains XX frames, the most complex of which took up to four hours to render. The large rendering task was divided among three sites, the graphics division in Westwood (4-7 machines), the corporate headquarters in Boston (10-12 machines), and the fish farm at the manufacturing plant (20 machines). A script was sent over the network to each site and loaded on a central, controlling machine, which

parceled out individual frames to other machines at the site. (Models for each object were stored at each site to save time loading objects.)

The central machine monitored each machine and its frame, farming out frames to idle machines. If a machine died, the central machine made a note of which frame was incomplete and put that frame at the top of the queue. The software for this netrendering capability was written by Joseph Goldstone. The netrendering code worked well, although not well enough that the site could be left unattended.

The starfield was rendered separately of the foreground scenes because the precision of the UV coordinates and the precision of depth becomes unacceptably imprecise when the yon and clipping planes are further apart than ? S-Render automatically generated a matte for the background scene. The compositor was an analog type since S-Render's compositor was not yet finished.

Postproduction

Once the rendering was complete, image data was returned to the graphics division on tape. Jim Ryan recorded the data onto 1" videotape, making separate tapes for the foreground scene, starfield, and the starfield matte. These tapes were later composited. (See the article "Alpha Channel" for details on how the alpha channel was used to composite the images.)

The audio was added this time. The music, like the film, underwent several incarnations. (Music was written only after the film was done.) The first piece, which accompanied the jury version, was almost an experimental piece. Once the tone and storyboard of the film were changed, "Doc" Bailey wrote music that was greatly liked and that actually helped move the film toward a happy resolutions. Unfortunately, Doc Bailey had other obligations and could not make the changes to his music that was required by the final ending. Jill Frazer wrote the music for the final version.

After the film

After the film was done and shown, good things started falling into

place for the filmmakers. The film was well-received at SIGGRAPH. Craig Reynolds delivered his paper on behavioral animation and was able to point to the success of the film to show it worked. Symbolics received much free and favorable publicity from the film, with pictures of Stanley and Stella appearing on the covers of graphics magazines.

The success of the film came as a bit of surprise for people, but everybody was quick to jump on it. The film became the marketing tool for selling the system.

The developers had devoted a lot of time to the film, but had learned much about animation that is of interest for their animation customers.